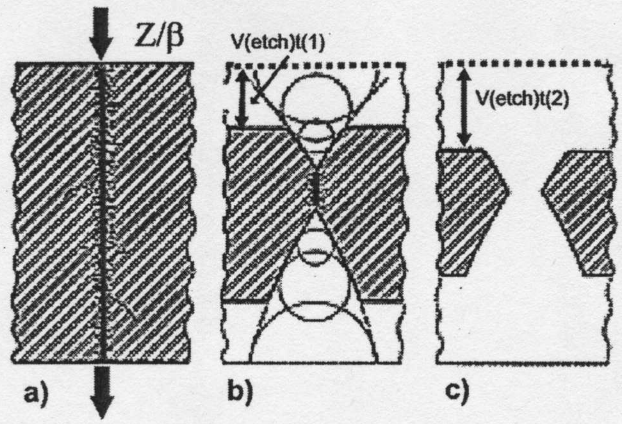
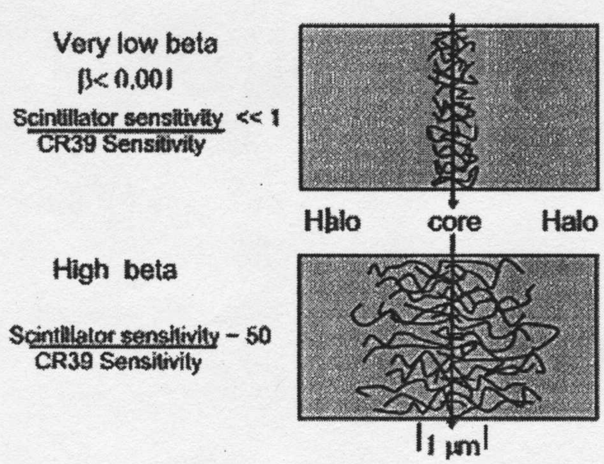
Track-Etch Detectors

The MOEDAL detector consists of an assembly of two kinds of plastic track-etch detector CR-39 and lexan.

The passage of a highly ionizing particle through the track-etch detector is marked by an invisible damage zone along the trajectory. The damage zone is revealed as a cone shaped etch-pit when the surface of the plastic detector is etched in a controlled manner using a hot sodium hydroxide solution. The depth of the etch pit is an increasing function of the Z/β of the particle. A schematic description of the etching process is given in the figure directly below

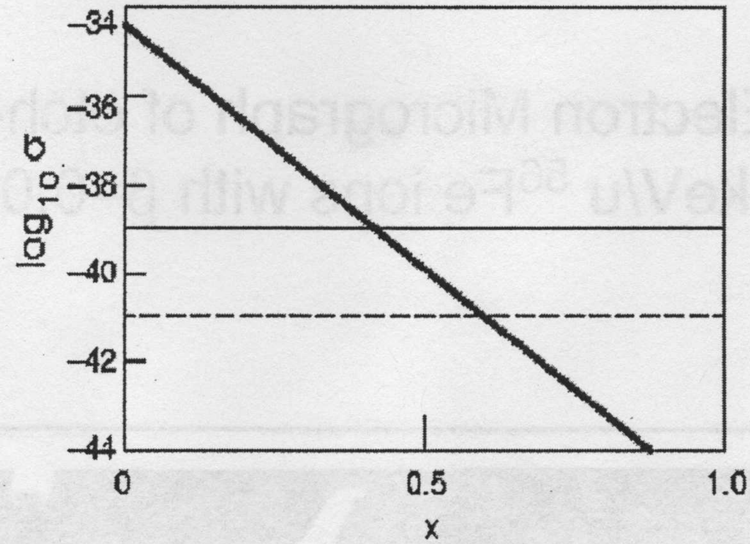


A powerful feature of etchable track-etch detectors is that their response depends only on the dose within 10^{-6} cm of the particle's trajectory and is independent of dose rate. It is possible to make precise measurements of Z/β of the particle. out to large values of Z/β as shown in the figure below.

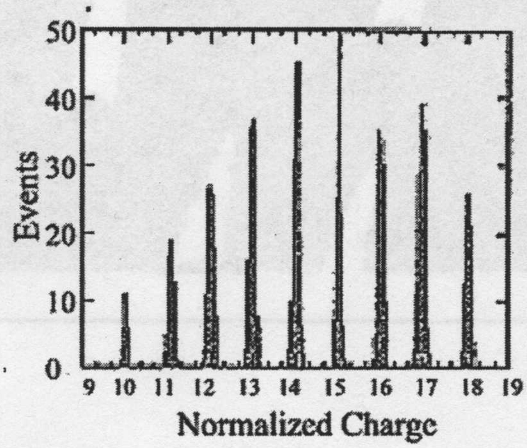


Because of radiation quenching in the dense core region near a monopole trajectory a plastic scintillator is more sensitive to energy deposited in the halo by δ-rays.

The response of several types of track-etch detector as a function of Z/β is given in the figure below.



Response of various types of track-etch detector as a function of Z/β



Example of charge resolution attainable with CR-39 track-etch detector

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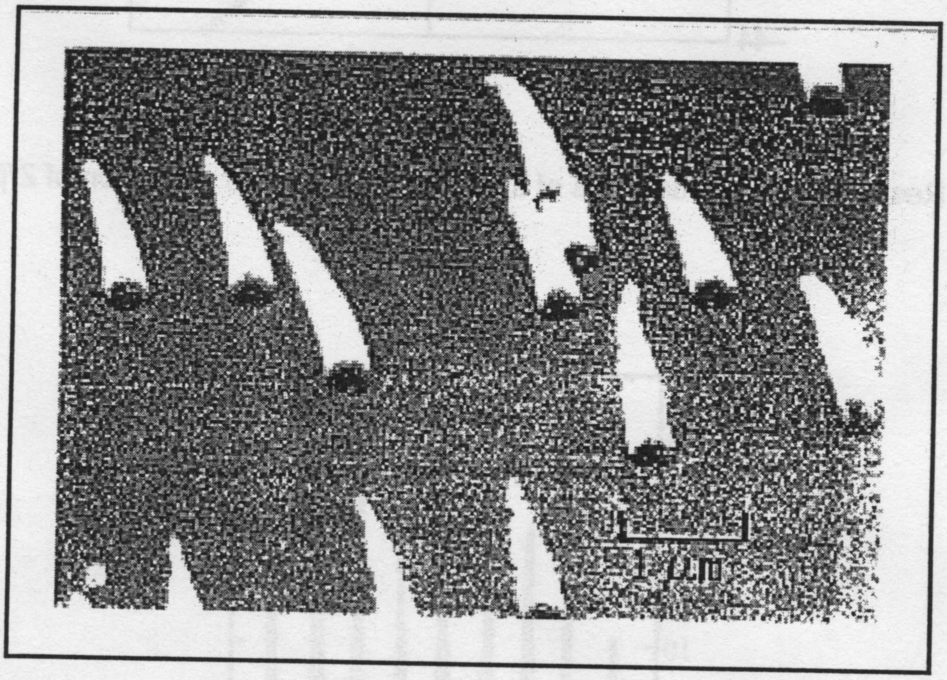
A Scanning Electron Micrograph of etch-pits made by 26 keV/u ^{56}Fe ions with β=0.007.



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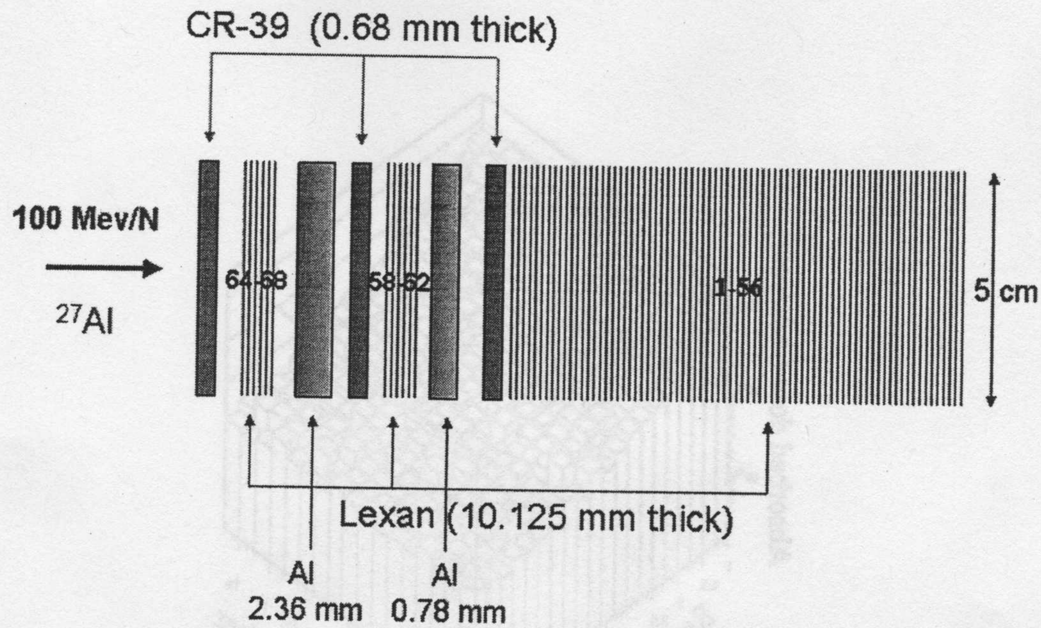
Calibration of Plastic Track-Etch Detectors

Plastic track-etch detectors can be calibrated for the detection of very highly ionizing particles using heavy s. For example the lexan plastic for the OPAL search was calibrated using the stack of plastic shown schematically below, using a beam of 100 MeV/N Al^{27} ions (Z/β= 30). Plastic from each batch utilized by the MOEDAL detectors will be calibrated prio to exposure at the LHC.



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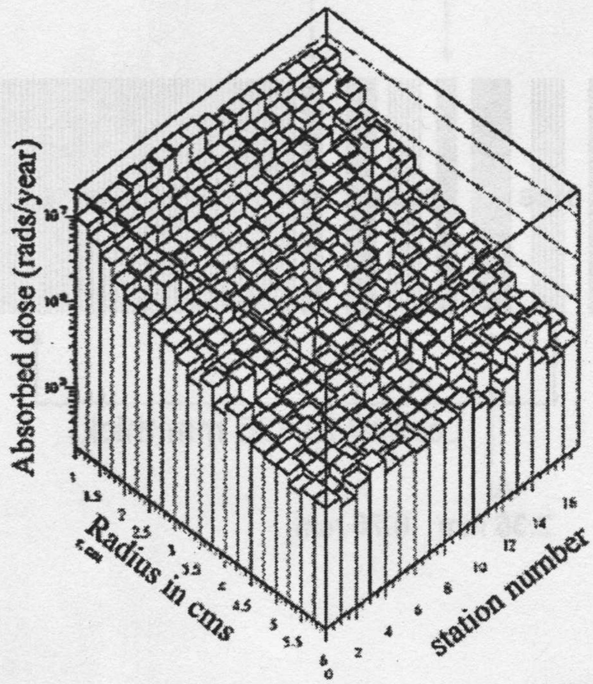
Radiation Environment of the MOEDAL Detector

Absorbed dose rates at IP8 (LHCb/MOEDAL intersection region) corresponding to a luminosity of 5 x 10^{32} cm^{-2} s^{-1} for a year (10^7 s) are shown below. For example the radiation dose received 6 cm from the beam axis is estimated to be ~400 krad for an integrated luminosity of 5 x 10^{39} cm^{-2}. Roughly the same integrated luminosity is requested for MOEDAL with Lexan/CR39 detectors that can withstand 200 Mrads and will be deployed 100 cm from the intersection point.



Radiation environment at the LHCb vertex detector area, as calculated by V. Talanov and reported in LHCb 98-019

Radiation Test of Lexan and CR39 Plastic Track-etch Detectors

In January 2000 there were a series of radiation tests of lexan track-etch detectors by the Alberta and Montreal groups using plastic supplied by the Bologna group. The irradiation was performed at the University of Montreal. Three beams were use:

- protons at 10 MeV;
- neutrons at 0.7 MeV; and,
- Cl ions at 30 MeV.

Three different samples of plastic were employed:

- CR-39-1.4 mm;
- CR-39-0.6mm;
- Lexan 0.5 mm.

The fluences experienced by the plastic samples were:

- in the case of the neutron beam 10^9 -->10^{13}. particles per cm^2 ;
- in the proton case from 10^9 -->10^{14}. particles per cm^2 ;
- in the CI case, from 10^9 -->10^{13}. particles per cm^2.

We are currently awaiting the results of the etching study of these foils.

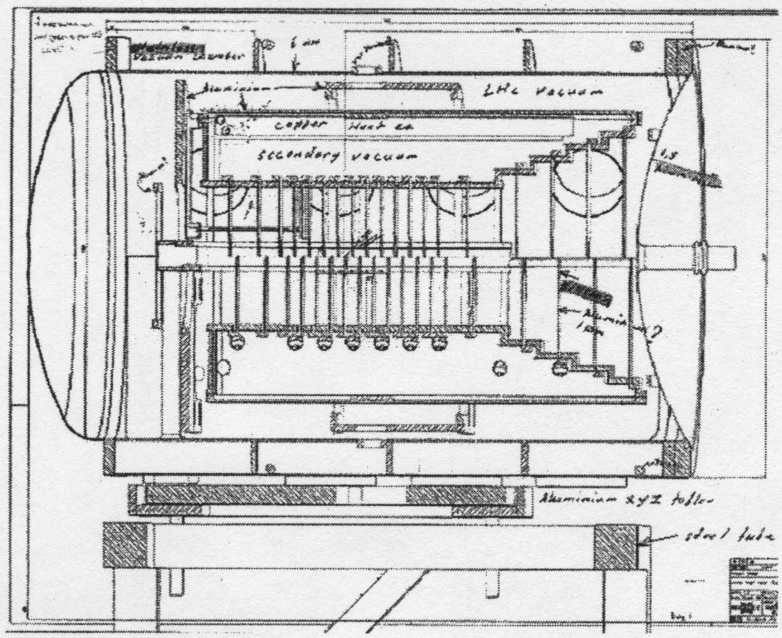
HOMEPAGE

MOEDAL at the LHCb Intersection Region

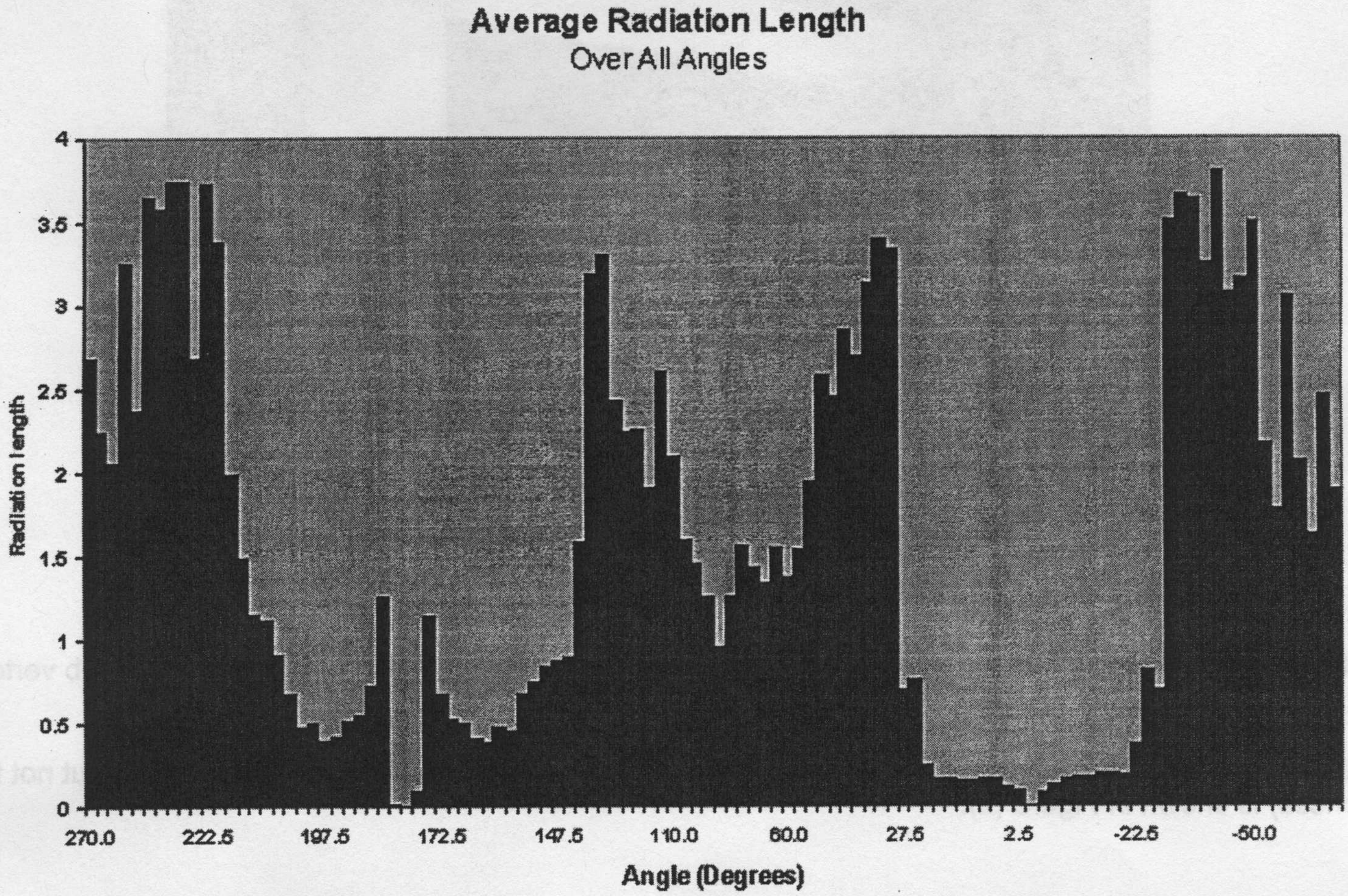
(The design of the final MOEDAL detector must take into account the requirements of the LHCb experiment. In the ent of conflict, the requirements of the LHCb collaboration as expressed by the LHCb spokesman, take preceden

Material in the Vertex Region

We expect that the MOEDAL track-etch detector would cover 50%->70% of the solid available around the LHCb vertex detector vacuum vessel. A drawing of the LHCb vertex detector vessel and SMVD support structure is shown directly below.



The amount of material presented by the LHCb vertex chamber, support structure and vacuum vessel is estimated by using "Geantinos" originating from the vertex position within the vacuum vessel. The material budget in terms of radiation lengths is shown below.



A preliminary mock-up of the LHCb intersection region

The three photographs show a preliminary mock-up of the LHCb intersection region where it is envisaged the MOEDAL detector will be deployed. The concrete beam and walls shown in Figure (1) indicate the dimensions of the tunnel in which the LHCb vertex detector (and region) is housed. The wooden box shows the 3-D footprint of the LHCb RICH detector. The LHCb vertex detector and MOEDAL would lie behind the RICH on the beam tunnel side.